ORIGINAL ARTICLE

Assessment of hand functions in rheumatoid arthritis using SF-SACRAH (short form score for the assessment and quantification of chronic rheumatoid affections of the hands) and its correlation to disease activity

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Abstract Rheumatoid arthritis activity is generally evaluated by using DAS-28 score. But this does not reflect the extent of functional hand impairment, a decisive parameter for patient wellbeing as well as for work disability. Several questionnaires to quantify the hand involvement in RA have been elaborated, amongst which SACRAH has been popular since 2003. But this requires evaluating 23 questions on a visual analogue scale. The questions were reduced to 12 in modified-SACRAH (M-SACRAH) and to only five questions in short form SACRAH (SF-SACRAH) so as to make it easily applicable in daily clinical practice. A study was planned to compare M-SACRAH (already validated) to SF-SACRAH in Indian population as no Indian data are available on the same. A total of 100 patients of RA were evaluated for disease activity using DAS-28 score and hand functions using M-SACRAH and SF-SACRAH. The M-SACRAH and SF-SACRAH were then compared based on DAS-28 scores; also M-SACRAH was compared to SF-SACRAH using Spearman's correlation coefficient. The mean value of DAS-28 score was 3.15 ± 0.86. The mean value of SF-SACRAH was 8.065 ± 7.44, and mean value of M-SACRAH was 201.7 ± 201.1008. The correlation of DAS-28 score to SF-SACRAH and M-SACRAH was significant in moderate and high disease activity but insignificant in remission and low disease activity state. The correlation between M-SACRAH and SF-SACRAH showed a spearman's coefficient of 0.998 with a P value of <0.001 (significant correlation). Correlation was significant for all disease activity states and for remission. The study suggests that the disease activity of rheumatoid arthritis (as assessed by DAS-28 score) has a poor correlation with hand functions (as assessed by M-SACRAH and SF-SACRAH) especially in low disease activity and remission states. Further, M-SACRAH and SF-SACRAH are significantly correlated. Therefore, it is suggested that RA patients should be assessed by SF-SACRAH (which includes five questions only) in addition to DAS-28 scoring for better evaluation of hand functions, a detrimental factor in day to day performance of RA patients.

Keywords Rheumatoid arthritis · Hand functions · Disease activity · SF-SACRAH · M-SACRAH · DAS-28

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Introduction

Rheumatoid arthritis (RA), a chronic multisystem disease of unknown aetiology, is characterised by persistent inflammatory synovitis usually involving the peripheral joints in a symmetrical distribution. The potential of synovial inflammation to cause cartilage damage and bone erosion with subsequent changes in joint integrity is the hallmark of the disease [1].

Table 1 M-SACRAH; it comprises of 12 questions

Domain	Questions
Function	1. Locking/unlocking a door
	2. Buttoning up/unbuttoning
	3. Turning a water tap
	4. Fastening/unfastening a zip
	5. Tying shoe laces
	6. Unscrewing a toothpaste cap
	7. Turning the pages of a newspaper
	8. Writing by hand
Stiffness	9. Daily morning stiffness
	10. Starting stiffness after a time of a rest
Pain	11. Pain during intensive work
	12. Pain at times of inactivity

Table 2 SF-SACRAH; It comprises of 5 questions

Domain	Questions
Function	How difficult was it for you during the last 48 h to:
	Unlock your door with a key?
	To do up or undo a zip?
	To turn the pages of the newspaper?
Stiffness	How severe was your joint stiffness immediately after waking up first thing in the morning
Pain	How severe was your pain at times of inactivity in the evening?

Rheumatoid arthritis (RA) is one of the most common disorders causing hand impairment in Rheumatology. Criteria such as tender and swollen joint counts, patient's global assessment (PatGA) or physician's global assessment (PhGA) and determination of laboratory parameters such as erythrocyte sedimentation rate (ESR) or C-reactive protein (CRP) usually mirror disease activity but do not reflect the extent of functional hand impairment, a decisive parameter for the patient's well being as well as work disability. Several questionnaires to quantify the hand involvement in rheumatoid arthritis have been elaborated like superior limb section of arthritis impact measurement scales (AIMS2), functional index for hand arthropathies (FIHOA), Duruoz Hand Index, disability of the arm, shoulder and hand questionnaire (DASH), Michigan hand outcomes questionnaire (MHOQ), cochin index and the Australian/Canadian osteoarthritis hand index (AUSCAN) [2–9].

A score was developed in 2003 for the assessment and quantification of rheumatoid affections of the hand known as SACRAH, a questionnaire comprising of 23 questions to be answered by visual analogue scales (VAS 0–100 mm) covering the three domains of function, joint stiffness and pain [10]. This questionnaire was modified (M-SACRAH) in 2004 by reducing the number of questions to 12 (Table 1) with a minimum of two questions covering each domain [11]. However, all these questionnaires, including the two SACRAHs, did not meet the requirements to be applied in daily routine, either due to too many questions or difficult and time consuming calculations or both. Therefore, SF-SACRAH (short form score for the assessment and quantification of chronic rheumatoid affections of the hands) was developed in 2009. This questionnaire with five questions (Table 2) is easily applicable in daily clinical practice. Rintelen et al. have shown that Cronbach's alpha was validated to 0.869 (indicating high internal consistency) in RA patients whereas patient's satisfaction and SF-SACRAH values were significantly correlated (P value <0.001) proving the score's external validity [12].

The main objective of this study was to assess whether the shortened version of the M-SACRAH, i.e. the SF-SACRAH, could be used as a completely patient administered tool for daily monitoring. The SF-SACRAH should enable physicians to get reliable information about the disease course based on the patients' report, and it should be sensitive enough to sound the alarm if deteriorations occur. A practicable and easily calculable tool for assessment of hand impairment can be regarded a prerequisite for effective and successful patient monitoring in clinical routine. The objective of the study was to assess the validity of SF-SACRAH as compared to M-SACRAH in daily monitoring of hand functions and its relation to disease activity (i.e. DAS-28 score).

Materials and methods

A total of 100 literate patients of rheumatoid arthritis satisfying the ACR criteria (1987) reporting to the Rheumatology Clinic of Pt. BD Sharma, P.G.I.M.S. Rohtak were enrolled in the study.

Exclusion criteria

All patients of rheumatoid arthritis who were severely anaemic, hypothyroid, having evidence of severe renal, cardiac, liver or pulmonary disease and those with obvious deformities were excluded from the study.

A written informed consent was taken from all the patients. The subjects underwent clinical evaluation and routine lab investigations including radiographic examinations. For DAS-28 score, 28 joints count (tenderness/swelling), ESR (using Wintrobe's method, in mm/first hour) and global health assessment using Visual Analogue Scale (VAS in 0–100 mm) was assessed. With the use of the above measurements, DAS-28 score was calculated to assess the severity of RA by using the following formula:

Table 3 Showing the distribution of subjects

Subgroups	DAS-28 (total score = 0–9.4)	Number of subjects	Mean DAS-28 ± SD
I	<2.6 (remission)	25	2.08 ± 0.45
II	≤3.2 (low disease activity)	27	2.89 ± 0.21
III	>3.2 and ≤5.1(moderate disease activity)	28	3.89 ± 0.45
IV	>5.1(high disease activity)	20	5.62 ± 0.29

$$DAS-28 = 0.56\sqrt{TJC} + 0.28\sqrt{SJC} + 0.70(\log ESR) + 0.014(GH)$$

[TJC = Tender joint count, SJC = Swollen joint count, ESR = Erythrocyte sedimentation rate, GH = Global health on VAS (in 0–100 mm)].

All subjects were scored for M-SACRAH and SF-SACRAH on the same visit. To avoid an interaction, patients completed both questionnaires after an interval of half an hour on average and in random order.

M-SACRAH was measured on 12 VAS from 0 to 100 mm followed by adding and dividing the sum by 12. SF-SACRAH was scored on Likert scale (from 0 to 10) where zero as answer to the three questions concerning function meant 'possible without any difficulty' and 10 meant 'impossible'. For stiffness, a value of 0 indicated 'no stiffness' and 10 indicated 'marked stiffness'. For pain, 0 indicated 'no pain' and 10 'unbearable pain'. The SF-SACRAH score was the sum of answers given to each question with subsequent division by five. M-SACRAH and SF-SACRAH thus calculated were subjected to statistical analysis for the predictability of SF-SACRAH as a tool for the assessment of hand involvement in RA using spearmen's correlation coefficient.

Results

The mean age of the study group was 34 ± 19.8 years though the majority of subjects were above 40 years. There were 86 women and 14 men (M:F = 1:6.4). Based on DAS-28 score, all subjects were subdivided into four main subgroups (Table 3). In the subgroup-I (25 patients), disease was in remission (DAS-28 score <2.6); subgroup-II (27 pts.) had low disease activity state (DAS-28 score >2.6 and <3.2); subgroup-III (28 pts.) had moderate disease activity state (DAS-28 score >3.2 and ≤5.1); and subgroup-IV (20 pts.) had high disease activity state (DAS-28 score >5.1). The subgrouping was done to compare the results and to assess the functional impairment of hands in the various disease activity states. When subjected to the M-SACRAH and SF-SACRAH, the mean scores were 201.7 ± 201.1008 and 8.065 ± 7.44, respectively. The M-SACRAH and SF-SACRAH when compared using the
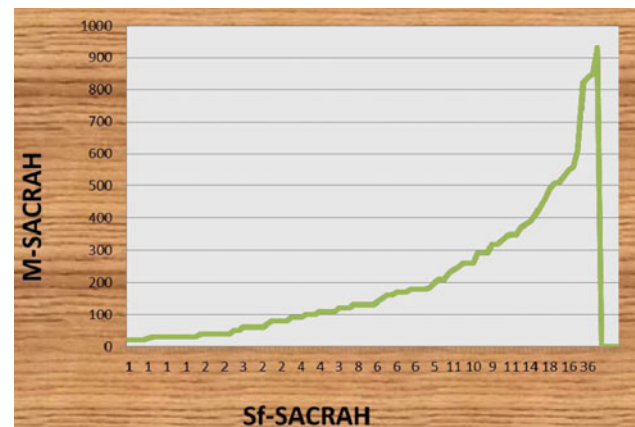
Fig. 1 Graph showing score of M-SACRAH and Sf-SACRAH

Spearman coefficient were found to be very significantly correlated (P value <0.001; Fig. 1). Based on the subgroups of DAS activity (Table 3), M-SACRAH and SF-SACRAH were compared in each subgroup with spearman's coefficient. Comparison between the M-SACRAH and SF-SACRAH using Spearman's correlation coefficient in the various subgroups based on DAS-28 score was 0.948 (P value <0.001) for the remission subgroup (subgroup-I), 0.933 (P value <0.001) for the low disease activity subgroup (subgroup-II), 0.936 (P value <0.001) for the moderate disease activity subgroup (subgroup-III) and 0.940 (P value <0.001) for the high disease activity subgroup (subgroup-IV; Table 4).

Comparison of the mean scores of M-SACRAH and DAS-28 was statistically significant with a P value <0.001 and r = 0.495 (Table 5). The results of comparison between the M-SACRAH and DAS-28 in various subgroups of the disease activity (based on DAS 28) using Spearman's correlation coefficient were 0.04092 (P value = 0.852) for subjects in remission (subgroup-I); for the low disease activity subgroup (subgroup-II), Spearman's correlation coefficient was 0.0736 (P value = 0.975); for the moderate disease activity subgroup (subgroup-III), Spearman's correlation coefficient was 0.4555 with P value = 0.001; and for the high disease activity subgroup (subgroup-IV), Spearman's correlation coefficient was 0.4962 and with P value = 0.001 (Table 5).

Table 4 Showing the score of M-SACRAH and SF-SACRAH in individual sub group with Spearman's correlation

Subgroup	M-SACRAH	SF-SACRAH	Spearman correlation coefficient	P value
I	62.2 ± 66.09	2.7 ± 2.31	0.948	<0.001
II	199.46 ± 190.84	8.41 ± 7.97	0.933	<0.001
III	272.71 ± 217.17	10.39 ± 7.5	0.936	<0.001
IV	261.42 ± 201.21	10.96 ± 6.5	0.940	<0.001

Table 5 Showing the correlation between M-SACRAH and DAS 28 score in various subgroups

Subgroup	Mean M-SACRAH ± SD	DAS28 ± SD	CO-COF. (r)	P value
I	62.2 ± 66.09	2.08 ± 0.45	0.04092	0.852
II	199.46 ± 190.84	2.89 ± 0.21	0.0736	0.975
III	272.71 ± 217.17	3.89 ± 0.45	0.4555	0.001
IV	261.42 ± 201.21	5.62 ± 0.29	0.4962	0.001

Table 6 Showing the correlation between SF-SACRAH and DAS 28 score in various subgroups

Subgroup	Mean SF-SACRA ± SD	Men DAS28 ± SD	CO-COF. (r)	P value
I	2.7 ± 2.31	2.08 ± 0.45	0.158	0.449
II	8.41 ± 7.97	2.89 ± 0.21	−0.071	0.724
III	10.39 ± 7.5	3.89 ± 0.45	0.493	0.001
IV	10.96 ± 6.5	5.62 ± 0.29	0.416	0.001

Table 7 Showing the relation between M-SACRAH and sub group based on duration of disease

Subgroup	Duration of disease	Number of subjects	Mean M-SACRAH ± DS	CO-COF (r)	P value
I	0–6 months	0			
II	6 months–2 years	29	236.724 ± 222.619	−0.22019	0.233
III	2–5 years	30	186 ± 199.734	0.03674	0.863
IV	>5 years	41	188.414 ± 187.414	0.04757	0.768

Correlation between mean DAS-28 and mean SF-SACRAH values was evaluated using spearman's correlation coefficient ($r = 0.477$) with a P value <0.001. The results of comparison in various subgroup of the disease activity (based on DAS 28) between the SF-SACRAH and DAS-28 using the Spearman's correlation coefficient were 0.158 (P value = 0.449) for the remission subgroup (subgroup-I), 0.071 (P value = 0.724) for the low disease activity subgroup (subgroup-II), 0.493 (P value = 0.001) for the moderate disease activity subgroup (subgroup-III) and 0.416 (P value = 0.001) for the high disease activity subgroup (subgroup-IV), (Table 6).

The mean duration of disease of study group was 5.10 ± 5.94 years. Based on total duration of disease (but irrespective of the severity of disease), the subjects were further divided into 4 sub groups. Subgroup-I comprised of early rheumatoid arthritis (duration of disease 0–6 months), subgroup-II comprised of established rheumatoid arthritis (duration of disease 6 months–2 years), subgroup-III comprised of late rheumatoid arthritis

(duration of disease 2–5 years) and the subgroup-IV comprised of chronic rheumatoid arthritis (duration of disease >5 years). There was no subject in subgroup-I, 29 subjects in subgroup-II, 30 subjects in subgroup-III and 41 subjects in subgroup-IV. In each subgroup, M-SACRAH and SF-SACRAH were compared with the same subgroup of duration of disease using spearman's correlation coefficient (Tables 7 and 8). The correlation of both SF-SACRAH and M-SACRAH with duration of disease was not found to be statistically significant.

Discussion

Rheumatoid arthritis is a disabling disease (disability being contributed both by disease activity and damage) contributing to great amount of morbidity and mortality in the diseased population. The progressive nature of rheumatoid arthritis (RA) often leads to severe disability [1, 2], (including work disability) and economic burden for the

Table 8 Shows the relation between SF-SACRAH and sub group based on duration of disease

Subgroup	Duration of disease	Number of subjects	Mean SF-SACRAH ± DS	CO-COF	P value
I	0–6 months	0			
II	6 months–2 years	29	8.431 ± 7.328	−0.0603	0.569
III	2–5 years	30	8.066 ± 8.66	0.17671	0.707
IV	>5 years	41	7.804 ± 6.69	−0.0118	0.944

society. Work disability is further increased by involvement of the hands. Numerous studies have been carried out to assess the disease activity, but little attention has been paid to assess the function of the hand. Patients in disease remission as per DAS-28 scoring may not necessarily have normal function of hand as it is likely that the disease severity and function of hands may not be parallel or equal. Methods of determination of functional impairment in arthritic hands include assessment of pain and disability by using various questionnaires like the score for assessment and quantification of chronic rheumatoid affections of the hands (SACRAH) [11, 12], and the Jebsen-Taylor hand function test [13]. Therefore, the purpose of the current study was to examine the relation between a self-reported hand function measure using SF-SACRAH and M-SACRAH, and also to look into the relation between disease activity and function of hands using DAS-28. Limited work has been done to compare these questionnaires in rheumatoid arthritis, and no work has been done in India to look into the validity of SF-SACRAH in the Indian population.

Mean age of the study group was 34 ± 19.8 years with a M:F ratio 1:6.4. According to Malaviya et al., the prevalence of rheumatoid arthritis in Northern India, which included several areas of Haryana adjoining to Delhi state, ranges from 0.5 to 3.8% in women and from 0.15 to 1.37% in men (approximately 3–4 times higher in women than men) [14]. A study conducted in All India Institute of Medical Sciences by Shini et al. showed that the mean age of onset was found to be 43.66 ± 12.31 years. The male to female ratio obtained was 1:5 [15]. In a study by Sautner et al., mean age of RA patients was 50.5 ± 15.6 years with 75.2% women [11].

For evaluation of the disease activity in RA, DAS-28 score is the gold standard. Mean DAS-28 score for the present study group (100 subjects) was 3.15 ± 0.86. Further, all the 100 subjects were divided into four subgroups of disease activity based upon DAS-28 score (according to ACR 2008 guidelines; Table 3). After evaluating the subjects for disease activity, the functional impairment of hands was scored by using the M-SACRAH on VAS scale and the SF-SACRAH on Likert scale. Mean SF-SACRAH for all the subjects in study group (100 subjects) was 8.065 ± 7.44 and mean M-SACRAH was 201.7 ± 201.008. The scores of both M-SACRAH and SF-SACRAH were compared using Spearman's correlation coefficient ($r = 0.9426$), which was

statistically significant (P value <0.001). The primary outcome of study revealed that the SF-SACRAH is as effective as M-SACRAH for the assessment of hand functions in rheumatoid arthritis. Similar results were also revealed by another study conducted by Rintelen et al. in which SF-SACRAH was found to be significantly correlated to M-SACRAH (P value <0.0001) [12].

Further, to look into the relationship between the two scores at various disease activity states, M-SACRAH and SF-SACRAH in each subgroup of disease activity (as per DAS-28 score) were compared to same subgroup of disease activity using Spearman's correlation (Table 4). The analysis showed spearman's coefficient, $r = 0.948$ (P value <0.001) for group I (remission); $r = 0.933$ (P value <0.001) for group II (low disease activity state); $r = 0.936$ (P value <0.001) for group III (moderate disease); $r = 0.940$ (P value <0.001) for group IV (high disease). Thus analysis revealed that SF-SACRAH can be substituted with M-SACRAH in various disease activity states. The study conducted by Rintelen et al. showed that the Alpha for the SF-SACRAH in 176 rheumatoid arthritis patients amounted to 0.869 indicating high internal consistency [12]. SF-SACRAH was found to be significantly correlated to M-SACRAH (P value <0.001). Patient satisfaction (PatSAT) and SF-SACRAH values were highly significantly correlated ($P < 0.001$), hence, proving the score's external validity [12].

It is believed that the functional impairment of hands is mainly due to pain, stiffness and swollen joints. Tender and swollen joints are also important parameters in calculating disease activity. So to look into the relationship between disease activity and hand function, DAS-28 was compared with M-SACRAH and SF-SACRAH separately. When the scores of M-SACRAH of all 100 subjects were compared with DAS-28 scores using Spearman's correlation co-efficient (Table 5), the result was 0.495 (P value <0.05) i.e. a statistically significant association. Similarly, when the scores of Sf-SACRAH of all 100 patients were compared with DAS-28, the Spearman's coefficient was 0.495 (P value <0.001); which is statistically significant. These results suggest that disease activity is associated with impairment of hand functions.

However, the analysis between DAS-28 and M-SACRAH showed Spearman's coefficient, $r = 0.04092$ (P value = 0.852) for group I (remission); $r = 0.0736$

(P value = 0.975) for group II (low disease); $r = 0.455$ (P value <0.001) for group III (moderate disease); $r = 0.496$ (P value <0.001) for group IV (high disease; Table 5). These results suggested that at moderate and high disease activity, there is good correlation between disease activity and hand function impairment. The patients having low disease activity state and in remission still have impaired function of hand. Similarly, when the score of SF-SACRAH was compared with DAS-28 using Spearman's correlation coefficient, the results were $r = 0.158$ (P value = 0.449) for group I (remission); $r = -0.071$ (P value = 0.724) for group II (low disease); $r = 0.493$ (P value <0.001) for group III (moderate disease); $r = 0.416$ (P value <0.001) for group IV (high disease; Table 6). The results were similar in both SF-SACRAH and M-SACRAH in each sub group. The analysis suggests that SF-SACRAH is equally valid as M-SACRAH in various sub groups of disease activity. The study by Murat Birtane et al. showed that hand functions had significant correlation with disease activity and radiological damage is not related to the severity of hand function deterioration [16]. They also found significant positive correlation between Duruoz Hand Index (DHI) scores and DAS-28 in the whole study population. A positive correlation between the same parameters was observed in patients with active disease, whereas no significant correlation could be observed in patients in remission. Thus, the comparison of M-SACRAH and SF-SACRAH with DAS-28 revealed that the patient may have functional morbidity while he is in remission or in low disease activity state that may need intervention to improve the quality of life.

To establish the relation between the functional impairment of hands in rheumatoid arthritis and the duration of disease, all the 100 subjects were further divided into the four subgroups (Tables 7 and 8) based upon duration of disease. Each sub group based upon the duration of disease was compared with the scores of both M-SACRAH and the SF-SACRAH using the Spearman's correlation coefficient. The results of comparison between the M-SACRAH and the duration of disease showed spearman's coefficient, $r = -0.22019$ (P value = 0.233) for the subgroup-II (established rheumatoid arthritis); $r = 0.03674$ (P value = 0.863) for the subgroup-III (late rheumatoid arthritis) and $r = 0.04757$ (P value = 0.768) for the subgroup-IV (chronic rheumatoid arthritis; Table 7). The inference drawn from the above results suggested that the functional impairment of hands has no relation with the duration of disease. Similar results were found when the duration of disease and the SF-SAC-RAH was compared using the Spearman's correlation coefficient (r). The Spearman's correlation coefficient (r) for the subgroup-II (established RA) was -0.0603 (P value = 0.569); for the subgroup-III (late RA) $r = 0.17671$ (P value = 0.707) and for the subgroup-IV

(chronic rheumatoid arthritis); $r = -0.0118$ (P value = 0.944; Table 8). The above analysis revealed that function of hand is independent of duration of disease.

The course of this disease develops most rapidly during the first few years. However, early initiation of therapy is associated with mitigated disease and disability within the first 3 months of diagnosis [17]. Mathilda et al. recently reported that there is rapid improvement in hand function and health-related quality of life after early initiation of therapy [18]. On a longer time perspective, contradictory conclusions have been drawn. Combe et al. reported that after 5 years of diagnosis, there is improvements regarding disability compared to baseline, although other researchers have found signs of functional deterioration 5 years after diagnosis [19].

The present study was an attempt to show that SF-SACRAH, a simple self-report tool obtained by answering a simple questionnaire based upon routine tasks involving hand movement, has equal relevance and excellent correlation with M-SACRAH for routine assessment of hand functions. Being a short questionnaire, it needs less than 1 min to complete and can be easily used in a busy OPD. It is a valid instrument with which to follow patients with RA.

Using the numerical summation, this SF-SACRAH score is very easy to calculate and no laboratory investigations are required rendering it cost effective. Its reliability guarantees timely intervention to arrest the functional impairment in RA particularly when the disease is in remission. Since hand impairment does not correlate with the duration of the disease, the SF-SACRAH can be used for quick decision making by the physician as it avoids the lags in efficient treatment modification for patients with rheumatoid arthritis. According to the current knowledge available, such intensified and prompt patient care can be expected to reduce the individual and socio-economic impact of the disease in the long run. However, future studies are required to compare the functions of the hand and disease activity with the duration of the disease.

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